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pH Modelling for the Ocean of Enceladus

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Measurements made by the Cassini spacecraft instruments were able to reveal the composition of the geysers of the Saturn moon, Enceladus, among which salts (sodium chloride, sodium bicarbonate and / or sodium carbonate) and traces of silica [Postberg et al., 2008, 2009] could be the result of hydrothermal processes [Hsu et al. (2014)] from the interaction of an inner liquid ocean with the core of Enceladus.

Many attempts [Glein et al. (2015), Marion et al. (2012), Hsu et al. (2014), Postberg et al. (2009) and Zolotov(2007)] to determine the properties of the ocean of Enceladus, such as the pH, have been done, however the geochemical parameters are still under debate. Nevertheless, the actual composition of the core, as well as the inner temperatures, are key factors to understand the chemistry of the ocean.

In this work we present a hydrothermal model that we use to estimate a pH range of values for the ocean based on three tidal dissipation powers (1, 10 and 100 GW) that lead to different ocean depths and thickness of the hydrated layer of the core. Given the uncertainties in the composition of the nucleus, we also consider three different compositional scenarios: (a) primordial/semi-primordial (ordinary and carbonaceous chondrites), (b) non-primordial (basalts and peridotites) and (c) a mixed composition (igneous inclusion of a chondrite carbonaceous). The ocean water in contact with the core rock is considered a solution where water and other compounds (e.g., N and C) have a similar proportions as those found in the geysers. In order to simulate the potential geochemical processes between the nucleus and the ocean and for chemical speciation and rock-water-gas balance calculations, we use the software PHREEQC. At least, our pH estimates for a mixed-composition core are between near 5 and 8 in the range of temperatures between 0º and 300ºC, such that, in average, the pH values become more basic with increasing temperatures.